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Influence of jute agro textiles on improvement of broccoli productivity in inceptisols

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Abstract
To investigate the effect of various jute agro textiles (g/m^2) on yield of broccoli and soil moisture conservation along with other soil properties, a field experiment was conducted at the University farm of Regional Research Station, New Alluvial zone of Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, Nadia, West Bengal.Five treatments viz. T_1 –800 GSM, T_2 -600 GSM, T_3- 400 GSM, T_4- 200 GSM jute agro textiles and T_5–control were used for the experiment in RBD. Yields of the crop, obtained from different treatments were 4.44 t/ha, 3.70 t/ha, 3.33 t/ha, 2.96 t/ha and 2.22 t/ha in 800,600,400,200 GSM and control respectively. Moisture use efficiency (avg.38.15 % over control) of soil was significantly higher under increasing strength of jute agro textiles. Though maximum yield was produced in T_1-800 GSM but, from percentage point of view T_2-600 GSM is the most economical for broccoli cultivation. Results indicated that the strength of T_1- 800 GSM was found to be the most efficient in increasing yield and moisture use efficiency of broccoli as well as in improving the physical and chemical properties of soil.

Keywords: crop yield, bulk density, porosity, water use efficiency

Introduction
In the arena of over exploitation of natural resources, restoration and scientific management of soil and water resources lead to sustainable development and quality enrichment of the environment. In this context, jute agro textiles, as a surface cover materials, have various potentials for maintaining soil quality and protecting the soil against any form of degradation (Hu *et al*., 2000; Pain *et al*., 2013) [11, 6]. Jute agro textiles (JAT), a natural product of eco-friendly and biodegradable fibre material, made from 100% natural bast fibre. It contains natural substances for plant growth and helps to serve and release of essential plant nutrients through lignin decomposition (Ranganathan, 1994) [15]. Geotextiles can provide instant rain splash and runoff control, creating a stable non-eroding environment (Mitchell *et al*., 2003) [9]. Geotextiles constructed from organic materials are highly effective in erosion control (due to their 100% biodegradability) and vegetation establishment, in spite of the fact that synthetic geotextiles dominate the market (Langford and Coleman, 1996) [8].
Broccoli, (*Brassica olaracea c.v. italica)*, is an important cash crop whose large flower-head is eaten as a vegetable. It is an excellent source of vitamins and minerals and can be used in table as well as cooking purpose, so the demand of broccoli is gradually increasing day by day. India is the second largest producer of broccoli after China, while the US ranks third. However, the productivity of the crop gradually decreases due to declining soil fertility status and inadequate availabilities of water and other resources.
On this background, efficient use of jute agro textiles have the opportunity to act as soil conditioner to drive soil related constraints out and enhancing broccoli production. Keeping in view, the present study was conducted to assess the efficiency of various strength of jute agro textiles (g/m^2) on improvement of broccoli yield and quality of soil in this new alluvial zone of West Bengal.

Materials and Method
Experimental Site
Investigations were conducted at the university farm of Region Research Station, New Alluvial Zone, Bidhan Chandra Krishi Viswavidyalaya, Gayeshpur, Nadia, West Bengal represented by sub-tropical climatic region. The farm is located at 22^{0}58' N L, 88^{0}26' E L, with an altitude at 10.9 m above MSL having average rainfall of 1500-1600 mm/year with variation of temperatures between 10^0-38^0 C. Being a haplaquepts, the soil of the area are characterized by low organic carbon, acidic nature and medium fertility status.

Methodology

The experiment was conducted from November 2014 to Mid February, 2015 using five treatments i.e. T_1 –800 GSM, T_2 - 600 GSM, T_3- 400 GSM, T_4- 200 GSM jute agro textiles and T_5–farmer's practices (control) along with NPK dose of 20-40-40 kg/ha with all the treatments where GSM = gram per meter square. All the treatments were replicated four times in Randomized Block Design with growing broccoli (var. Palam Samridhi). The area of each plot was 36 sq.m with spacing of 60 cm X 45 cm. The recommended package of practices was adopted for growing the crop. Jute agro textiles were laid during the transplanting of the healthy seedlings to the main field (Fig. 1.) The physical properties of soil like texture, bulk density, porosity, moisture content, aggregates distribution etc were evaluated by the methods proposed by Piper (1966). The organic carbon status of the soil is determined by Wakley and Black method (1934). The pH, available nitrogen and potassium were measured by the standard procedure of Jackson (1973) [7] and phosphorus by Olsen's method (1954). Moisture use efficiency was calculated by the relationship as: MUE (kg/ mm/ ha) = Total yield (kg/ha) / Consumptive use of water (mm). All the data obtained were subjected to statistical investigation following the analysis of variance techniques by using software packaging of MS Excel and OPSTAT. Statistical significance between means of individual treatments was assessed using Fisher's Least Significant Difference (LSD) at 5% level of probability (Gomez and Gomez, 1984) [5].

Fig 1: One month aged broccoli crop with JAT

Results and Discussion

Yield of broccoli

The result of effects of different strength of jute agro textiles on yields of broccoli presented on Table 1 and Figure 2& 3. Response of broccoli yield over control due to each treatment were 2.22 t/ha (100%), 1.92 t/ha (86.48%), 1.11 t/ha (50.00%) and 0.74 t/ha (33.33 %) respectively in jute agro textiles 800, 600, 400 and 200 GSM. The significantly highest yield ($P < 0.05$) of broccoli crop was observed in treatment T_1 - 800 GSM. But from percentage point of view, the yield increment was more in T_2- 600 GSM from T_3-400 GSM (36.48%) than T_1-800 GSM from T_2-600 GSM (13.52%). Similarly fruit weight and size were also highest in case of T_1 i.e. 1.2 kg (weight) which is double of the control and the response of others were 400g (66.6%), 300g (50%) and 200g (33.3%) respectively in T_2, T_3, T_4 treatments over control. The above findings was supported by Paza (2007) [12].

Fig 2: Matured broccoli crop

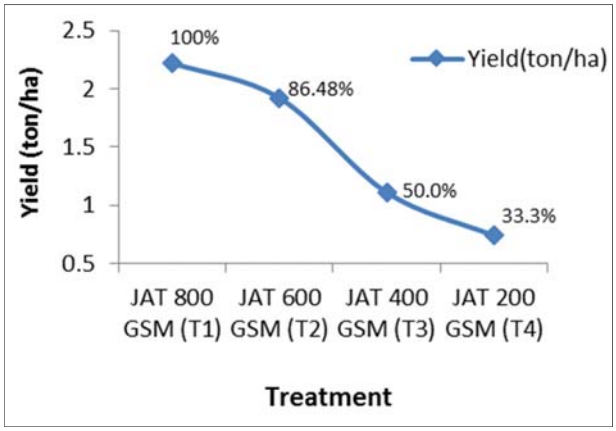

Fig 3: Response of yield in different strength of JAT over control

Table 1: Effect of Different strengths of JAT on yield and yield components of Broccoli

Treatments	Broccoli Weight (Kg)	Length of Broccoli (cm)	Diameter of Broccoli (cm)	Yield (ton/ha)
JAT 800GSM (T_1)	1.2	29.5	16.0	4.44
JAT 600 GSM (T_2)	1.0	27.4	14.5	4.14
JAT 400 GSM (T_3)	0.9	26.2	13.6	3.33
JAT 200 GSM (T_4)	0.8	25.0	12.0	2.96
Control(T_5)	0.6	20.8	11.8	2.22
SE (m) ±	0.1	1.44	0.78	0.37
CD at 5%	0.277	3.99	2.16	1.02

Soil Moisture Use Efficiency

Soil moisture content at every stage was higher under each of the treatment over control. The data of the moisture use efficiencies of the crop, were increased significantly over control by 3.16, 1.95, 1.4, 0.75 kg/ha/mm, generally on an average, 38.15% due to the treatments of T1, T2, T3 and T4 respectively. The highest MUE was observed in treatment 800 GSM i.e. 66.64 % and minimum MUE was in control plot (Figure 4). The changes of soil moisture content due to the treatments might be attributed by lower bulk density and higher porosity in soil towards increasing moisture retention capacity of soil. The above results supported by Nag *et al.* (2008) [10].

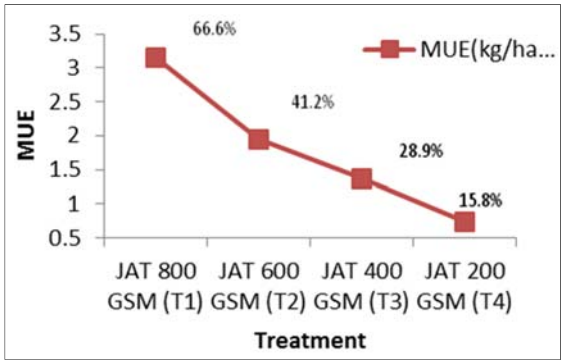

Fig 4: Response of Moisture Use Efficiency by Broccoli in different strength of JAT over control

Physical and chemical properties of soil

The results of the effects of different strength of jute agro textiles on the changes of soil physical as well as chemical properties are presented in Table 2. The water holding capacity of soil also gradually increased as the density of the agro textiles increase i.e. the highest WHC was seen in treatment T_1- 800 GSM. The value of organic carbon in soils due to application of treatments followed the order i.e. JAT 800 GSM (0.69%) > 600 GSM (0.67%) > 400 GSM (0.62%) > 200 GSM (0.61%) > control (0.45%). Increment of organic carbon content found highest in the plot under jute agro textiles 800 GSM (53.3%) over the control plot. JAT generally improves the soil fertility status, highest strength of applied JAT improves availability of N-P-K by 84.6%, 13.58%, 60.84% over control respectively.The above results are in agreement with those reported by Dutta and Chakraborty (1995) [4].

Table 2: Effect of different strength of JAT on soil physical and chemical properties

Treatment	Water holding capacity (%)	pH	Organic carbon(%)	Available Nitrogen (Kg/ha)	Available P_2O_5 (Kg/ha)	Available K_2O (Kg/ha)
T_1	49.05	6.82	0.69	79.4	25	246.1
T_2	46.79	6.80	0.67	73.6	24.8	310.5
T_3	46.56	6.73	0.62	71.3	23.2	176.3
T_4	46.56	6.73	0.61	71.1	23.0	176.1
T_5	41.42	6.70	0.45	43.0	10.6	153.0
SE (m) ±	1.18	0.036	0.025	1.19	0.626	0.136
CD at 5%	2.78	0.106	0.074	2.92	1.53	0.334

Soil structural indices

The results of the effects of various treatments on the indices of soil structure and their stabilization were presented in Table 3. Results clearly indicated much variation of all the indices of soil structure and their stability due to variation of treatments. The reduction of bulk density over control due to treatment T_1- 800 GSM was 0.06 (4.54%), with simultaneous increment of porosity by 3.87 (7.9%). The values of mean weight diameter (MWD), structural coefficient (SC) and water stable aggregates (WSA) were found highest under 800 GSM jute agro textile. Critical examination of data reveals that among the various treatments, application of 200 GSM, failed to show any significant changes of MWD, WSA and SC over control. Thus 800 and 600 GSM jute agro textiles were more effective for improving soil structure. The above findings corroborates with observations of several investigators who emphasized the importance of organic matter in stabilization of water stable aggregates through the formation of organic mineral complex, Biswas *et al.* (1970) [2] reported that the nature of organic matter played an important role in the development of soil structure owing to differential nature of by products produced during the process of decomposition.

Table 3: Effects of various jute agro textiles on the changes of physical properties and structural indices of soil

Treatment	BD (g/cc)	Porosity (%)	MWD (mm)	Structural coefficient	WSA>0.25%
T_1	1.26	52.8	2.970	0.831	83.99
T_2	1.28	51.7	1.872	0.812	82.38
T_3	1.29	50.9	0.743	0.702	71.70
T_4	1.30	50.2	0.742	0.700	71.70
T_5	1.32	48.93	0.706	0.514	58.47
SE (m) ±	0.005	0.011	0.03	0.01	0.99
CD at 5%	0.018	0.038	0.10	0.03	3.43

Conclusion

The effects of various strength of jute agro textiles on yield and yield components of broccoli crop as well as the changes of soil physical, chemical properties and soil moisture content have been investigated in the present study. All the jute agro textiles found to be much effective in increasing number of fruit/plant, size, weight thus yield of the crop over control along with the sharp improvement of soil structure, porosity, water holding capacity, fertility status as well as the organic matter content of soil. It also improves the moisture use efficiency of the crop, hence can be used in areas where water scarcity is a major problem. Acting as a mulching material, it improves the micro-environment i.e. optimum soil temperature and moisture leading to favourable nutrient supply to crops. Though all the agro textiles are very efficient, the most fruitful result was driven out from the treatment T_1-800 GSM on an overall basis.The yield was found to be highest in T_1-800 GSM but, from percentage point of view T_2-600 GSM is the most economical for broccoli cultivation if productivity is considered only. Thus the result leads to suggest that among the various strength of jute agro textiles tested, the strength of T_1- 800 GSM was found to be the most superior to increase the yield and moisture use efficiency of broccoli as well as to improve the fertility status and aggregation properties of soil.

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